



ENERGY USE ENGINEERING DEPARTMENT

PROJECT 8341

**PERFORMANCE TESTS AND EVALUATION
OF TECNECON FLUORESCENT DIMMER**

ENERGY CONSERVATION DIVISION

B.C. HYDRO AND POWER AUTHORITY



85-1293/

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PROJECT 8341

PERFORMANCE TESTS AND EVALUATION OF TECNECON FLUORESCENT DIMMER

SYNOPSIS:

A fluorescent lighting system with dimmer control can produce energy savings by:

- (a) reducing light output (and corresponding power input) when the lighting system is new;
- (b) reducing light output when there is a high contribution of daylight.

Tecnecon Electronics Inc., a Canadian manufacturer, currently produces a CSA approved dimming system for use with standard iron core fluorescent ballasts. The Varilite unit offers flexible control of illuminance levels and power input with a corresponding decrease in power factor and a small decrease in system efficiency. The current harmonics, introduced when the dimming system is connected into the circuit, result from the modification of the current waveform but do not present a major problem, as they may be removed by filtering.

PROJECT:

Initiated/Requested by:	R. F. Hughes
Date Completed:	10 August 1984
Completed by:	O. Stevens
Supervised by:	G.D.A. Henriques
Approved by:	<i>[Signature]</i>

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Initial Distribution:	EUE Supervisors
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ENERGY USE ENGINEERING DEPARTMENT
PROJECT SUMMARY

PROJECT No. 8341

PRIORITY 3

TITLE: Performance Tests and Evaluation of Tecnecon Fluorescent Dimmer

INITIATED/REQUESTED BY: R. F. Hughes

ASSIGNED TO: O. B. Stevens

ASSIGNED BY: G.D.A. Henriques

DATE ASSIGNED: 83 June 1

DATE REQUIRED: 84 June 31

ESTIMATED COMPLETION:

COMPLETED: 84 August 10

OBJECTIVES AND NOTES:

1. Design and construct an integrating cube photometer.
2. Calibrate the cube.
3. Perform tests on the dimmer to determine input power, power factor, voltage, harmonic content and lumens produced by 2-F40 CW fluorescent lamps with a standard iron core ballast, and establish relative efficiencies at various light levels between full output and the minimum setting.

COPIES TO: DEPARTMENT MANAGER (THEN RECORD FILE), BLUE FILE, SUPERVISOR, R. F. Hughes, P. P. Young, J. D. Falck

PLEASE ADVISE AS SOON AS POSSIBLE IF CHANGES ARE REQUIRED ABOVE

ENERGY USE ENGINEERING DEPARTMENT
ENERGY CONSERVATION DIVISION

B.C. HYDRO



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Project #7011-83, Tecnecon Varilite Dimmer Tests	

SUMMARY

The Tecnecon Varilite dimmer satisfactorily performs its function of reducing light levels and power input (from 45% to 110%). The lowered power factor and increased harmonics are minor problems that can be overcome. In spite of the reduced system efficiency at lower light levels, there is still a net reduction in energy use.

For complete details of the testing procedures and results, refer to Appendix I: B. C. Hydro Research and Development Project #7011-83, "Tecnecon Varilite Dimmer Tests".

BACKGROUND

A lighting system with output control (i.e. dimming) can provide energy savings by reducing the power input and light output. Dimming can be applied effectively when:

- (a) the light output needs fine tuning;
- (b) the system is new; before dirt and lamp aging have resulted in reduced light;
- (c) there is a significant amount of daylight contribution.

Fluorescent dimming has been expensive because the requirements of the lamps necessitated a change in ballast as well as the control system. Traditional voltage reducing dimmers, such as those for incandescent lamps, cannot be used. However, the recent rapid progress in solid state technology has resulted in a reduced circuit component cost and subsequently lower priced fluorescent dimming systems.

B. C. Hydro became aware of a Canadian manufacturer (Tecnecon Electronics Inc.) who is currently producing a CSA approved dimmer (the Varilite) for use with standard iron-core fluorescent ballasts. In order to provide sound customer advisory information on this product, it was decided that the Energy Use Engineering Department in cooperation with the Research & Development Division would test the product to verify manufacturer's performance claims.

RECOMMENDATIONS

1. B. C. Hydro should recognize and promote the use of light output control devices as a sound energy management practice.
2. The "Tecnecon Varilite" satisfactorily performs its function of dimming fluorescent lamps. Therefore, B. C. Hydro should produce and publish a Research Digest on this new product to provide customer advisory information.

APPENDIX I

B. C. HYDRO RESEARCH AND DEVELOPMENT

PROJECT #7011-83

TECNECON VARILITE DIMMER TESTS

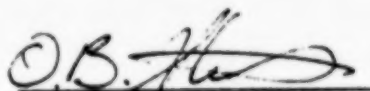
BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
RESEARCH AND DEVELOPMENT

TECNECON VARILITE DIMMER TESTS
PROJECT NO. 7011-83
JUNE 1984

ABSTRACT:

The Tecnecon Varilite offers flexible control of illuminance levels and power input of fluorescent luminaires that use standard iron core ballasts. However, the circuit power factor and system efficiency is reduced while current harmonic content is increased when the dimming system is connected into the circuit.

Prepared by:



O. B. Stevens
Electrical & Lighting
Technologist

Approved by:



W. Chin
Supervisor
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Utilization

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INTRODUCTION

At the request of Mr. R. F. Hughes tests have been conducted on a sample Tecnecon Varilite dimmer unit for fluorescent luminaires to determine:

- (a) the unit performance compared with manufacturers' literature;
- (b) the relative efficiencies at various test settings;
- (c) the power factor at various test settings;
- (d) the harmonics generated with the device in circuit.

The unit is manufactured by Tecnecon Electronics Inc., a Canadian Manufacturer currently producing a CSA approved fluorescent dimming system for use with standard iron core ballasts.

A fluorescent lighting system with dimmer control can produce energy savings by:

- (a) reducing light output (and corresponding power input) when the lighting system is new; before the light loss factor has become significant;
- (b) reducing light output when there is a high contribution of daylight.

TEST METHOD AND TESTS

An accurate method of measuring relative luminous flux was required to determine the efficiency. Therefore, an integrating cube photometer was designed and constructed for the purpose. The cube, which measures 4 ft by 4 ft by 4 ft, had a special barium sulphide finish applied to the interior to provide for almost complete diffusion of light.

After construction, the cube was "calibrated" using a Textronix J-16 photometer and two F40 cool white fluorescent lamps connected to an externally mounted G.E. Gold label ballast. A multiplying factor was

determined and used in the data acquisition computer program to convert the lux readings to a nominal value of lumens (i.e. 6,300 for two fluorescent lamps connected to a standard ballast).

Figure 7 shows the equipment connections. A reference test was completed using the standard G.E. Gold Label ballast (Model #17A240EW) with the Tecnecon dimmer disconnected. The Tecnecon dimmer was then tested from maximum setting to minimum setting (adjustments were made according to manufacturers' literature) in quartile steps. For all tests the lamps and ballast were allowed a 15-minute "settling" period. The tests included:

(a) measurements of:

- volts (held to $117V \pm 0.5V$);
- amps;
- watts;
- VAR's;
- lumens.

(b) capturing voltage and current waveforms using a digital storage oscilloscope;

(c) calculating:

- VA;
- power factor;
- efficacy;
- harmonics (from digitized waveforms).

Each measurement was taken five times and then averaged as a representative reading.

As each of the six tests were completed, the waveforms and results of measurements and calculations were plotted.

RESULTS

Figures 1 to 6 show the current and voltage waveforms, the measurements, and the per unit analyses of current harmonics for each test setting. Table #1 summarizes and compares the major results.

TABLE 1
Summary and Comparison of Major Results

	Reference: G.E. Gold Label Ballast	Tecnecon Dimmer Connected				
		Maximum Setting	0.75 of Maximum Setting	0.50 of Maximum Setting	0.25 of Maximum Setting	Minimum Setting
Volts	117.2	117.1	116.7	116.6	117.0	117.2
Power Factor (%)	99.1	98.8	91.1	83.3	78.7	75.9
Rel Power (%)	100.0	107.0	101.0	88.6	75.0	62.6
Rel Lum Flux (%)	100.0	101.0	90.0	79.9	67.7	57.1
Rel Efficiency (%)	100.0	94.4	89.2	90.2	90.2	91.3

When the Tecnecon dimmer is installed, the circuit power factor decreases proportionally with the amount of dimming. Therefore when the light level is reduced to 57%, the power factor drops from 99% to 76%.

Lowering the light output reduces the power input. However, the adverse difference between light reduction and power input reduction is caused by:

- (a) the dimmer requiring a small amount of power;
- (b) the bulb wall temperature being lowered to less than optimum for maximum light output of the lamps' phosphors.

This reduces the overall system efficiency by up to 10%.

The dimmer at minimum setting increases the third harmonics by approximately 280% and the seventh harmonics by 700%. This increase in harmonics must be considered when operating the dimmer around sensitive electronic equipment.

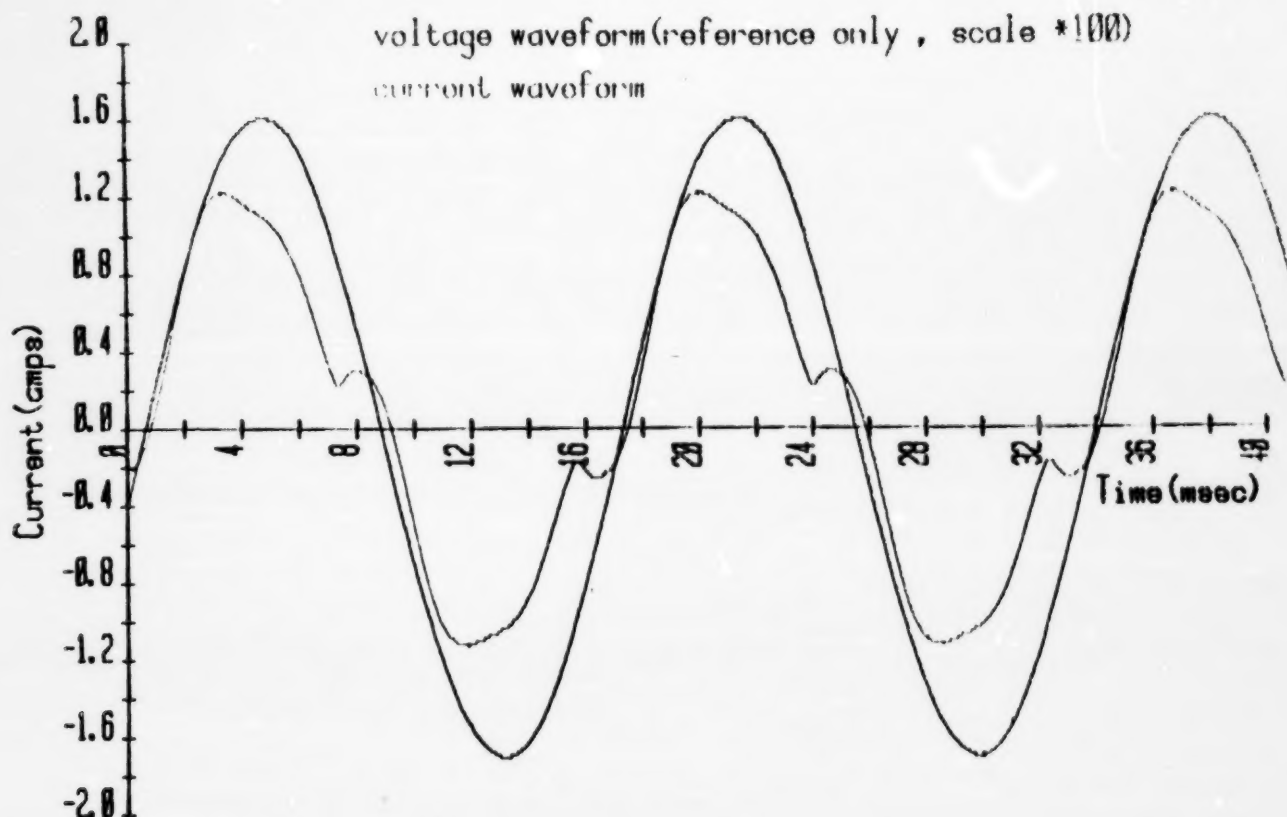
CONCLUSIONS AND RECOMMENDATIONS

The Tecnecon dimmer satisfactorily performs its function of reducing light levels and power input (from 45% to 110%). Both the lowered power factor and increased harmonics are minor problems that can be overcome. The lower system efficiency cannot be improved, however, it becomes more pronounced at lower light levels, and therefore there is a net reduction in energy use.

Appendix 1 contains manufacturer's literature of the Varilite system. Some options were not tested, therefore, no comment is implied regarding their use. However, the tested unit performed within expected tolerances of the published data.

This Tecnecon dimmer is a good alternative when fluorescent dimming control can be used to obtain a net reduction in energy use. In particular, it can be used with an external sensor for new lighting installations to keep illuminance levels constant over the system life and for installations that have a high daylight contribution.

Fig. # 1 G.E. Gold Label Reference Ballast



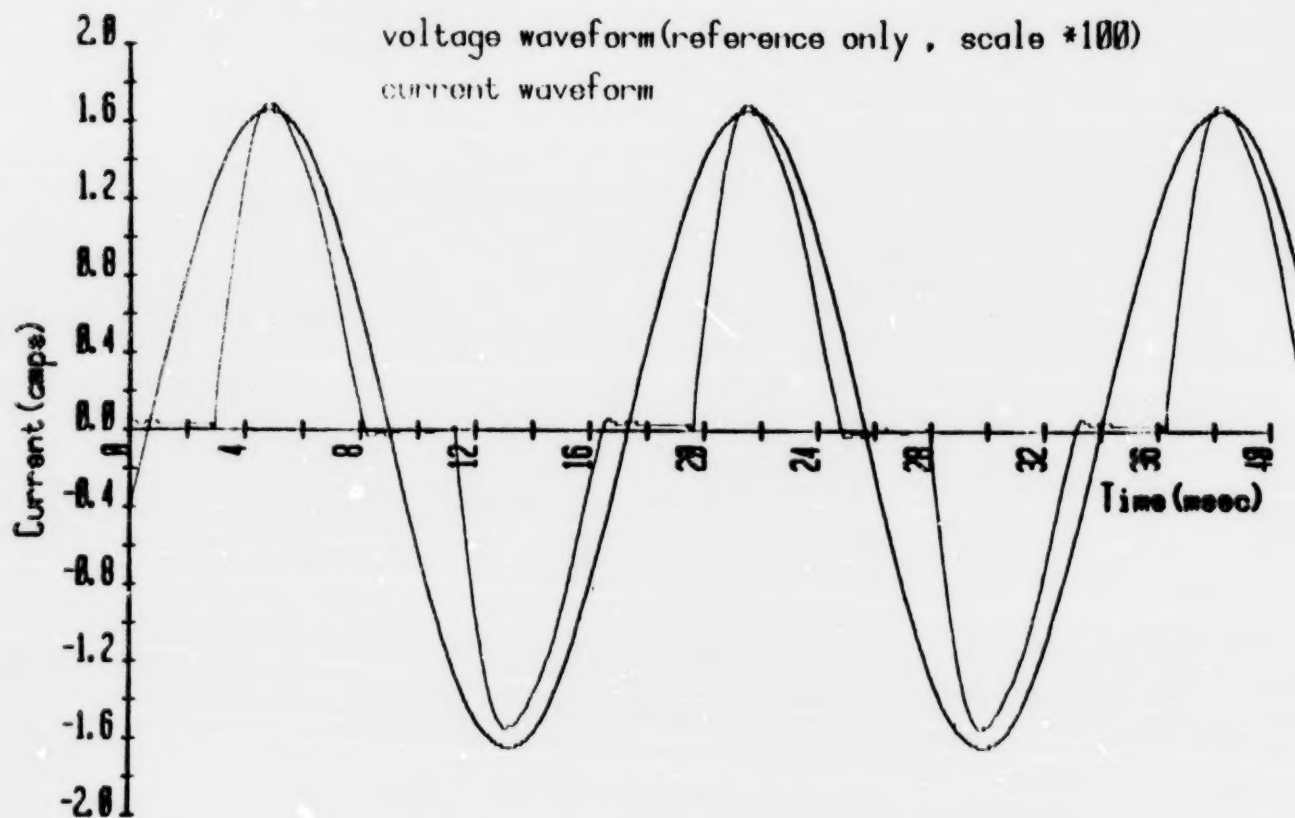
MEASUREMENTS :
(R. M. S.)

Volts : 117.2 V
Ampe : 0.80 A
Watts : 90.4 W
VARs : 12.4 var
VA : 91.2 VA
PF : 99.1 %
Lumens : 6257 lm
Efficacy : 69.2 lm/W

ANALYSES OF CURRENT HARMONICS :
(p. u. of fundamental)

2nd harmonic : 0.02
3rd harmonic : 0.19
4th harmonic : 0.01
5th harmonic : 0.10
6th harmonic : 0.01
7th harmonic : 0.01
8th harmonic : 0.01
9th harmonic : 0.01

Fig. # 2 Tecnecon Dimmer - Maximum Setting



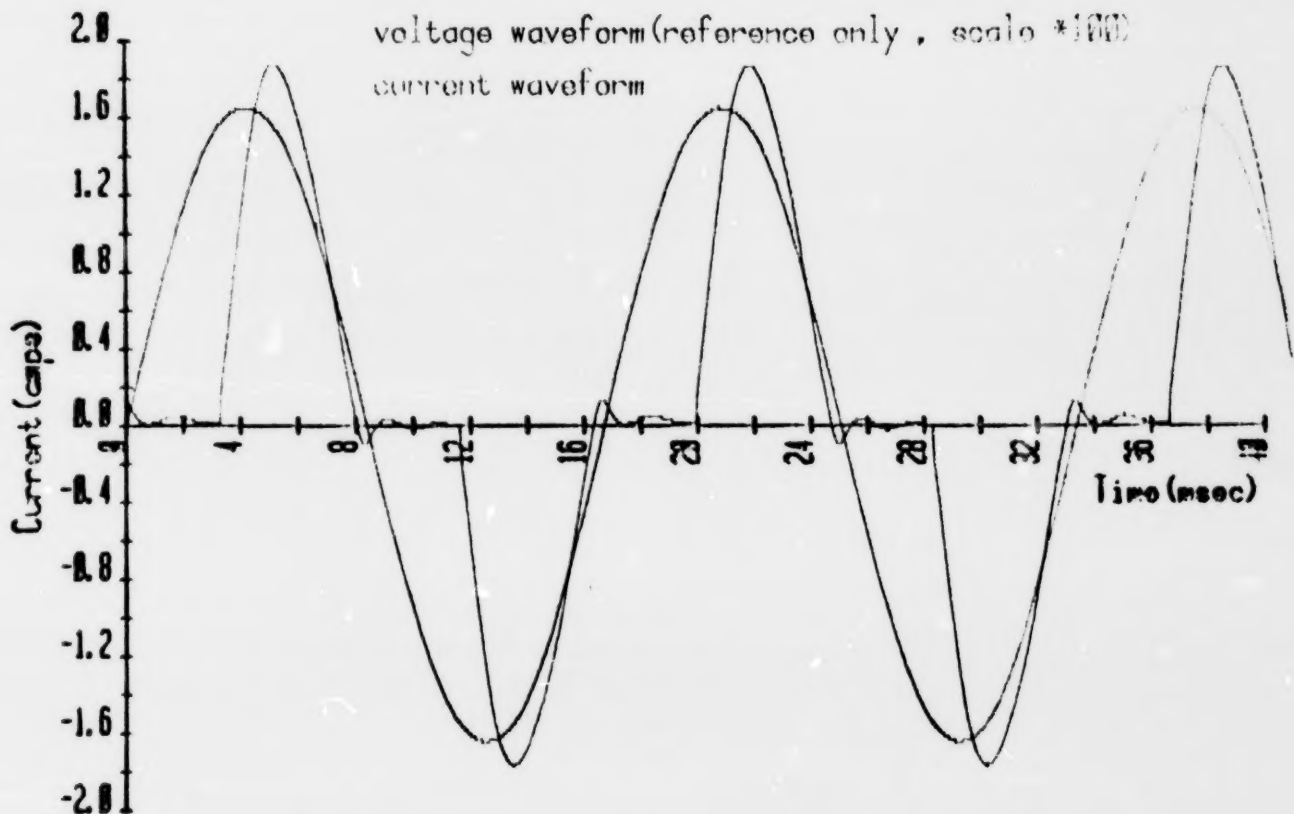
MEASUREMENTS :
(R. M. S.)

Volts : 117.1 V
Amps : 0.78 A
Watts : 96.5 W
VARs : 15.1 var
VA : 97.6 VA
PF : 98.8 %
Lumens : 6295 lm
Efficacy : 65.3 lm/W

ANALYSES OF CURRENT HARMONICS :
(p. u. of fundamental)

2nd harmonic : 0.03
3rd harmonic : 0.43
4th harmonic : 0.01
5th harmonic : 0.08
6th harmonic : 0.01
7th harmonic : 0.07
8th harmonic : 0.01
9th harmonic : 0.03

Fig. # 3 Tecnecon Dimmer - 0.75 of Maximum



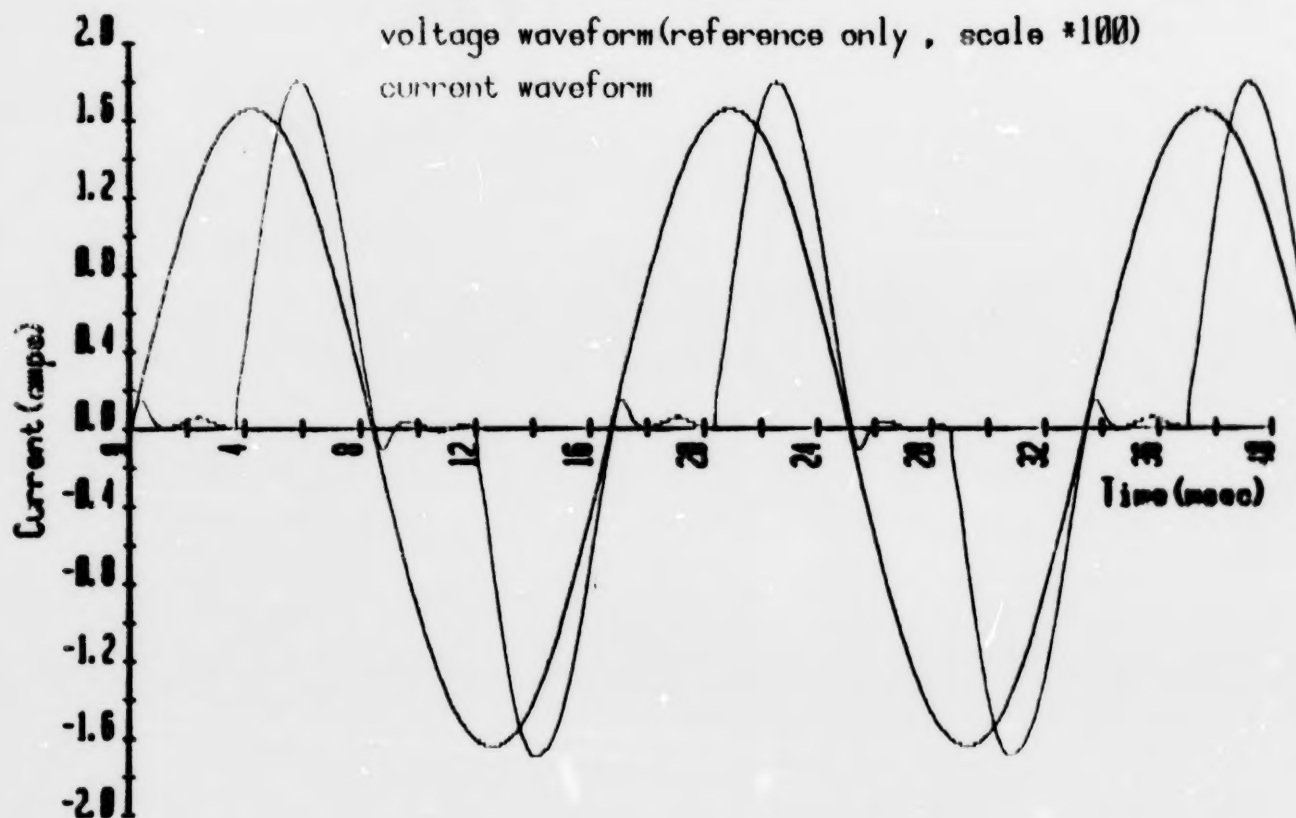
MEASUREMENTS :
(R. M. S.)

Volts : 116.7 V
Amps : 0.79 A
Watts : 91.3 W
VARs : 41.4 var
VA : 100.2 VA
PF : 91.1 %
Lumens : 5634 lm
Efficacy : 61.7 lm/W

ANALYSES OF CURRENT HARMONICS :
(p.u. of fundamental)

2nd harmonic : 0.03
3rd harmonic : 0.52
4th harmonic : 0.02
5th harmonic : 0.07
6th harmonic : 0.01
7th harmonic : 0.09
8th harmonic : 0.01
9th harmonic : 0.01

Fig. # 4 Tecnecon Dimmer - 0.50 of Maximum



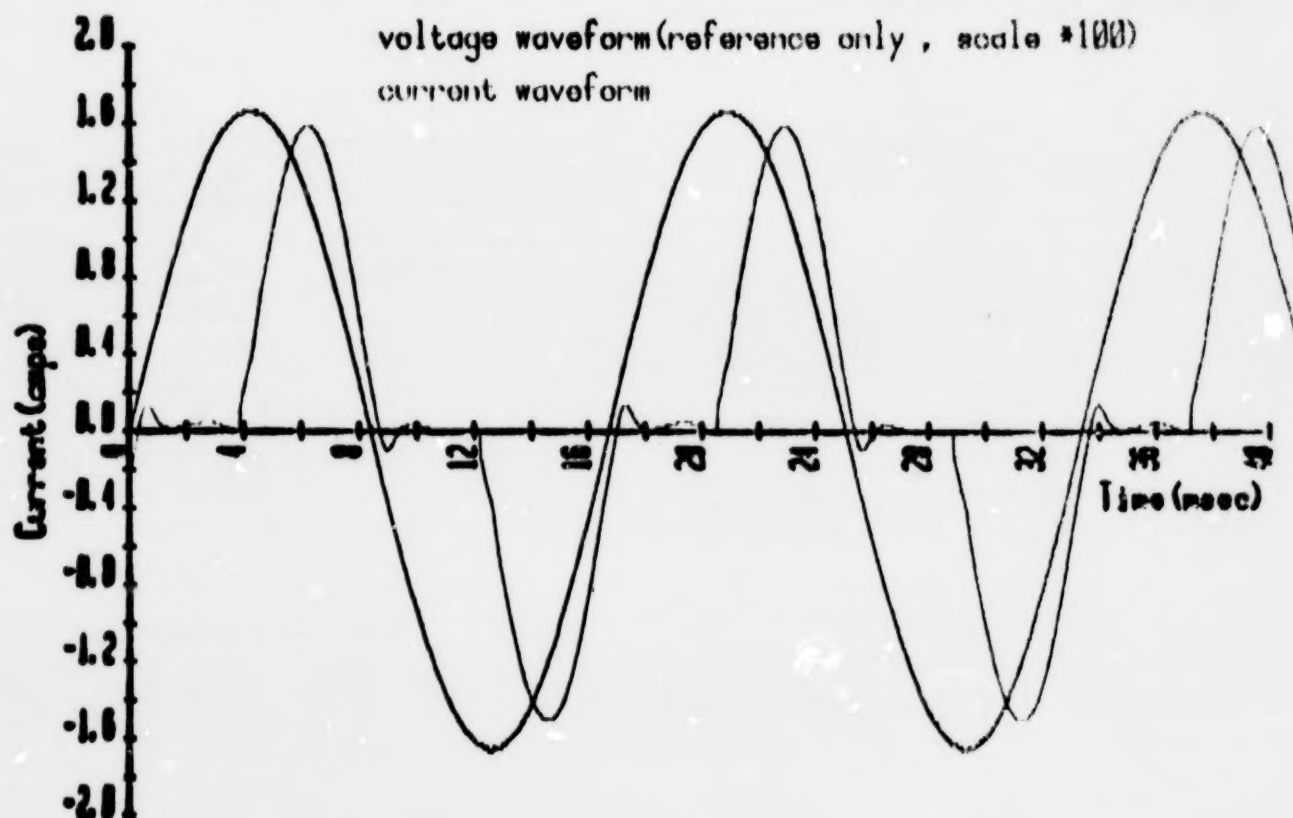
MEASUREMENTS :
(R. M. S.)

Volts : 110.0 V
Amps : 0.77 A
Watts : 88.1 W
VARs : 53.3 var
VA : 98.2 VA
PF : 83.3 %
Lumens : 4998 lm
Efficacy : 62.4 lm/W

ANALYSES OF CURRENT HARMONICS :
(p.u. of fundamental)

2nd harmonic : 0.83
3rd harmonic : 0.52
4th harmonic : 0.82
5th harmonic : 0.85
6th harmonic : 0.81
7th harmonic : 0.88
8th harmonic : 0.81
9th harmonic : 0.82

Fig. # 5 Tecnecon Dimmer - 0.25 of Maximum



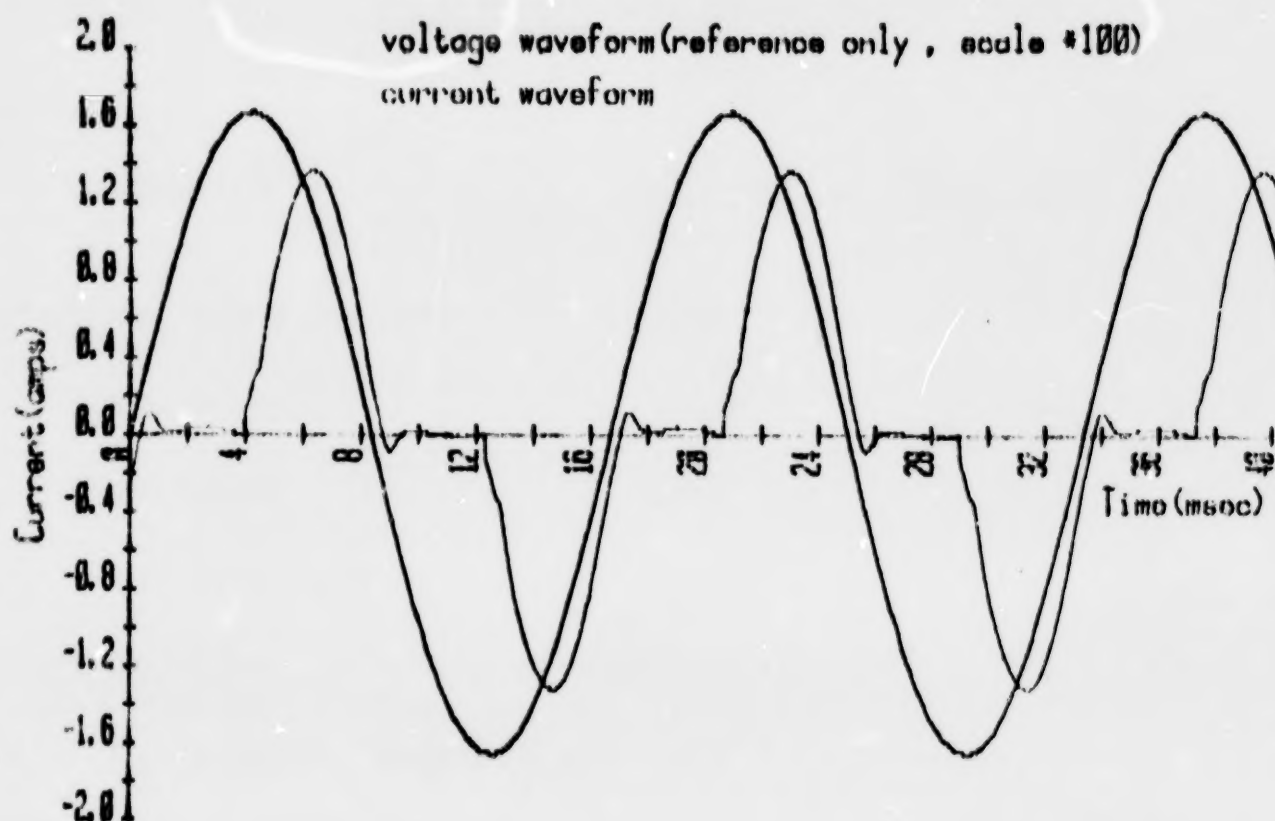
MEASUREMENTS :
(R. M. S.)

Volts : 117.0 V
Amps : 0.70 A
Watts : 67.0 W
VARs : 53.1 var
VA : 80.1 VA
PF : 78.7 %
Lumens : 4230 lm
Efficacy : 62.4 lm/W

ANALYSIS OF CURRENT HARMONICS :
(p.u. of fundamental)

2nd harmonic : 0.83
3rd harmonic : 0.52
4th harmonic : 0.82
5th harmonic : 0.85
6th harmonic : 0.81
7th harmonic : 0.87
8th harmonic : 0.81
9th harmonic : 0.82

Fig. # 6 Tecnecon Dimmer - Minimum Setting



MEASUREMENTS :
(R. H. S.)

Voltage	: 117.2 V
Amps	: 0.60 A
Watts	: 56.6 W
VARs	: 48.6 var
VA	: 74.6 VA
PF	: 75.9 %
Lumens	: 3574 lm
Efficacy	: 63.2 lm/W

ANALYSES OF CURRENT HARMONICS :
(p. u. of fundamental)

2nd harmonic	: 0.03
3rd harmonic	: 0.53
4th harmonic	: 0.02
5th harmonic	: 0.07
6th harmonic	: 0.01
7th harmonic	: 0.07
8th harmonic	: 0.01
9th harmonic	: 0.00

Fig. 7: Test Connections Block Diagram

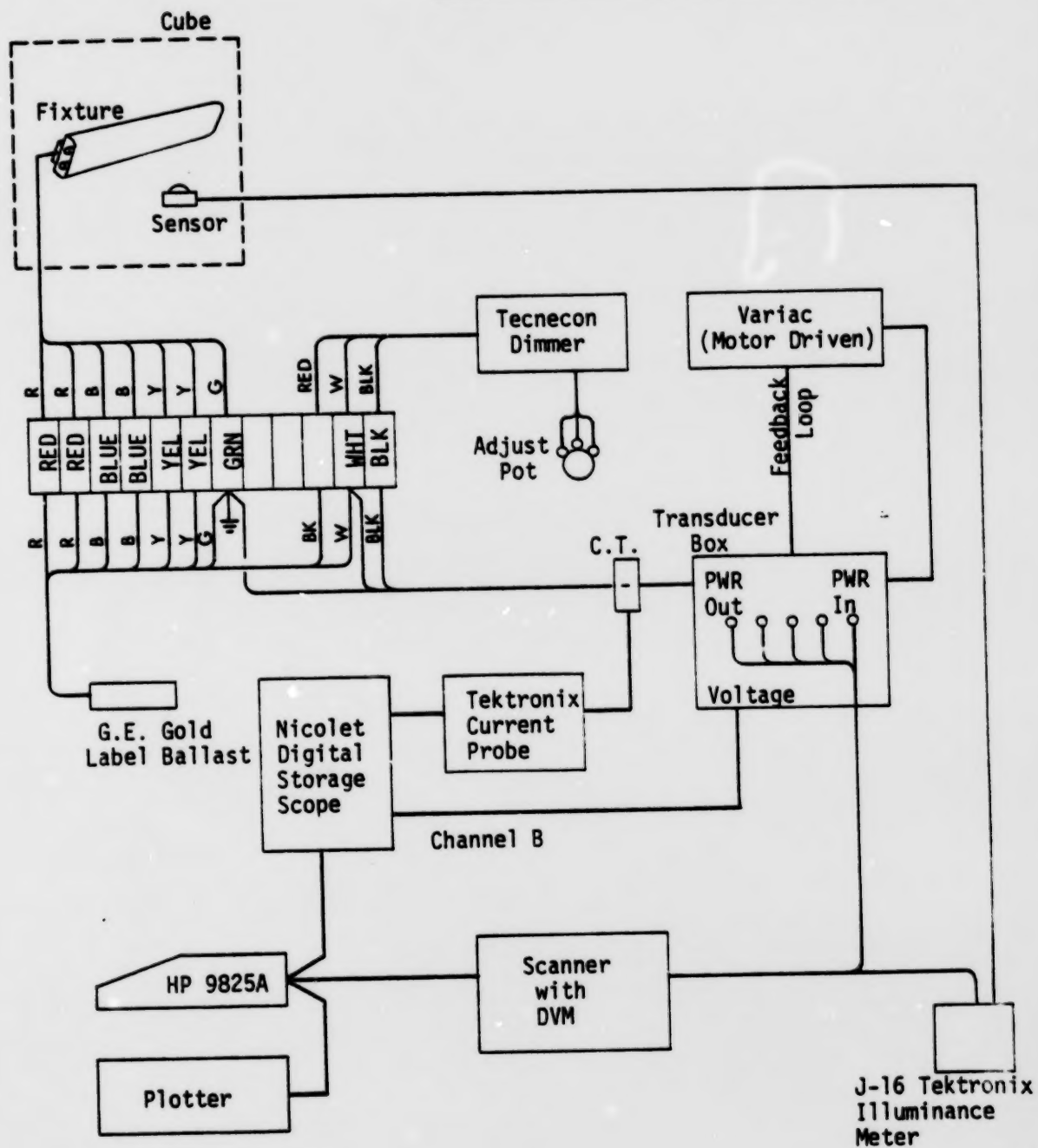


FIGURE 8 - LIST OF INSTRUMENTS USED

<u>DESCRIPTION</u>	<u>MODEL NUMBER</u>	<u>SERIAL NUMBER</u>
H.P. DESKTOP CALCULATOR	9825A	1637A 00302 SYSTEM 3052A
H.P. INTERFACE	98039A	
H.P. SCANNER	3495A	
H.P. DIGITAL VOLTMETER	3455A	
H.P. PLOTTER	9872A	
NICOLET DIGITAL STORAGE SCOPE	204-A	813114
TEKTRONIX CURRENT PROBE		
POWER MODULE	TM501	B089659
PROBE AMPLIFIER	AM503	B052893
TEKTRONIX DIGITAL PHOTOMETER	J-16	B010916
H.P. DIGITAL MULTIMETER	3466A	1716A 11551
STACO VARIAC	5M5010CT	
TECNECON VARILITE	TEC-120-18	
G.E. GOLD LABEL BALLAST	17A240EW	

APPENDIX 1

TECNECON ELECTRONICS INC. - VARILITE DATA SHEET



TECNECON ELECTRONICS INC.

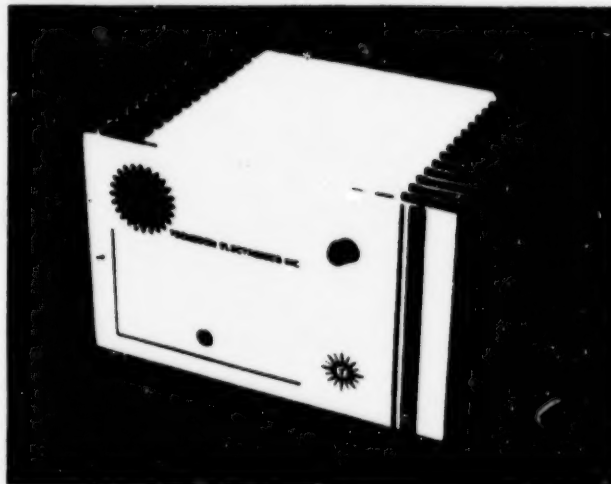
FLUORESCENT LIGHT CONTROL

FEATURES

- Solid state reliability
- Simple in-line installation
- No extensive wiring or ballast changes
- Controls complete lighting circuit
- Protected from transients and electronic interference
- Not load-sensitive
- Field adjustable

VARILITE

MODEL NO. TEC-120-18



Tecnecon's VARILITE puts you in control of your energy costs by allowing easy adjustment of light levels for maximum efficiency, rather than paying for unnecessary and costly over-illumination. The result is a customized lighting system adapted to individual needs, along with an impressive reduction in energy costs. With a dimming range from 100% down to 45% of the nominal light level, the VARILITE allows for optimum utilization of the luminosity in any given area with a corresponding decrease in power consumption. An additional 30% dimming and power saving can be achieved with

the installation of an inexpensive component in the fixtures.

VARILITE's advanced design has eliminated flickering, flashing and other disruptions, producing an improved working environment as well as longer tube life. It may be pre-set at any dimming level and will upon restarting, automatically dim to the pre-set level after only 7 seconds of boosting.

Each VARILITE unit has a Standard Integral Control to decrease and maintain reduced light levels for comfort and energy savings. Depending on individual requirements, the VARILITE may also be controlled

by a variety of methods. The Remote Control option allows for immediate, personal control where varying light levels are required. Another option, the Photocell Control automatically adjusts the light output to prevent variations in the light level caused by natural, ambient light, thereby producing a totally stabilized level of illumination. Timers, computers and microprocessors may be interfaced with the VARILITE, providing for fully automated regulation of lighting levels. The variety of control options offers customized fluorescent lighting systems, designed to meet individual needs in lighting and energy conservation.

TECHNOLOGICAL BREAKTHROUGH

Tecnecon has made controlled fluorescent lighting possible without the expense of costly tube replacement resulting from premature burn-out and will, in fact, extend

the functional life of fluorescent tubes.

Designed by an international team of experts, the VARILITE is a major achievement in today's technology in that it has a crest factor of

only 1.8 — well below the accepted maximum of tested laboratory standards. (High crest factors are extremely detrimental to lamp and ballast life).

After two years of service in a commercial location, fluorescent tubes show signs of discoloration indicating excessive power consumption, inferior efficiency and limited life span.



After two years of service in a commercial location equipped with a Tecnecon VARILITE, fluorescent tubes show minimal signs of aging, promising superior efficiency and many more months of dependable service.

POOR

QUALITY

ORIGINAL